

CLAIMS

1        1. An optically pumped semiconductor laser device having a substrate (12)  
2        having a first main area (14) and a second main area (16), a pump laser (30) and  
3        a vertically emitting laser (40) optically pumped by the pump laser (30) being  
4        arranged on the first main area (14),

5        wherein

6        - the first main area (14) of the substrate (12) is patterned and has first regions  
7        (20) situated at a higher level and also second regions (18) situated at a lower  
8        level,  
9        - the pump laser (30) is arranged on a region (20) situated at a higher level of  
10      the substrate (12), and  
11      - the vertically emitting laser (40) is arranged above intermediate layers (50,  
12      30') on a region (18) situated at a lower level of the substrate (12),  
13      the height difference ( $\Delta$ ) between the first (20) and second (18) regions of the  
14      substrate (12) and the layer thickness of the intermediate layers (50, 30')  
15      being chosen in such a way that the pump laser (30) and the vertically emitting  
16      laser (40) are situated at the same level.

1        2. The semiconductor device as claimed in claim 1,

2        wherein

3        the pump laser (30) is formed by a semiconductor layer sequence and the  
4        intermediate layers (50, 30') comprise the semiconductor layer sequence (30') of  
5        the pump laser (30).

1        3. The semiconductor device as claimed in claim 1,

2        wherein

3        the intermediate layers (50, 30') comprise a mirror layer (50), which forms a  
4        mirror of a resonator for the vertically emitting laser (40).

1        4. The semiconductor device as claimed in claim 1,

2        wherein

3        the first regions (20) situated at a higher level and the second regions (18)  
4        situated at a lower level of the substrate are separated from one another by  
5        projecting webs (22).

- 1 5. The semiconductor device as claimed in claim 4,  
2 wherein  
3 the projecting webs (22) are transparent to the radiation generated by the pump  
4 laser (30).
  
- 1 6. The semiconductor device as claimed in claim 3,  
2 wherein  
3 the mirror layer is formed as a Bragg mirror (50).
  
- 1 7. The semiconductor device as claimed in claim 1,  
2 wherein  
3 the vertically emitting laser (40) is formed by a semiconductor layer sequence  
4 which has a quantum well structure as radiation-generating active layer (44).
  
- 1 8. The semiconductor device as claimed in claim 1,  
2 wherein  
3 during operation, the radiation generated by the pump laser (30) for pumping the  
4 vertically emitting laser (40) is coupled into an active layer (44) of the vertically  
5 emitting laser in the lateral direction.
  
- 1 9. The semiconductor device as claimed in claim 1,  
2 wherein  
3 the substrate (12) is formed from GaAs.
  
- 1 10. A method for producing an optically pumped semiconductor laser device having  
2 an optically vertically emitting laser and at least one pump laser, the method  
3 having the following steps:
  - 4 - provision of a patterned substrate having first regions situated at a higher level  
5 and second regions situated at a lower level;
  - 6 - application of an edge emitting semiconductor layer sequence to the substrate;
  - 7 - application of a surface emitting semiconductor layer sequence with a  
8 radiation-generating active layer, the height difference between the first and  
9 second regions of the substrate being chosen in such a way that the edge  
10 emitting semiconductor layer sequence of the first regions is situated at the

11 same level as the surface emitting semiconductor layer sequence of the  
12 second regions in order to form a pump laser for the optically vertically emitting  
13 laser during operation; and  
14 - removal of layers arranged above the edge emitting semiconductor layer  
15 sequence in the first regions in order to uncover the edge emitting  
16 semiconductor layer sequence there.

1 11. The method as claimed in claim 10,  
2 wherein

3 the edge emitting semiconductor layer sequence and the surface emitting  
4 semiconductor layer sequence are applied together in a single epitaxial step.

1 12. The method as claimed in claim 10,  
2 wherein

3 a mirror layer is applied to the edge emitting semiconductor layer sequence.

1 13. The method as claimed in claim 10,  
2 wherein

3 after the layers arranged above the edge emitting semiconductor layer  
4 sequence have been removed, contacts are applied to the edge emitting  
5 semiconductor layer sequence of the first regions.

1 14. The method as claimed in claim 10,  
2 wherein

3 the step of provision of a patterned substrate comprises the dry etching of a  
4 planar substrate in order to produce the first regions situated at a higher level and  
5 the second regions situated at a lower level.

1 15. The method as claimed in claim 10,  
2 wherein

3 the first regions situated at a higher level and the second regions situated at  
4 a lower level of the substrate are separated from one another by projecting webs.

1       16. The method as claimed in claim 12,  
2       wherein  
3       the applied mirror layer is formed as a Bragg mirror.

1       17. The method as claimed in claim 10,  
2       wherein  
3       the radiation-generating active layer of the surface emitting semiconductor layer  
4       sequence is formed as a quantum well structure.

1       18. The method as claimed in claim 10,  
2       wherein  
3       during operation, the radiation generated by the edge emitting semiconductor  
4       layer sequence for pumping the optically vertically emitting laser is coupled into the  
5       active layer of the surface emitting semiconductor layer sequence in the lateral  
6       direction.